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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION

1923

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HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture.]

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[1] Resigned June 30, 1923.

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REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1923.

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SUMMARY OF INVESTIGATIONS.

By J. M. Westgate, *Agronomist in Charge.*

During the fiscal year 1923 the station continued its policy of fostering the development of diversified agricultural industries in the islands. Special attention was given to the production of staple food supplies which, in either the raw or manufactured state, can be exported at a profit during normal times or used to feed the local population in the event of calamity befalling the sugar and pineapple industries or of interruption of shipping.

The scientific work of the station consisted in solving problems arising in connection with the development of agricultural industries. Perhaps the most important problem solved is that of overcoming chlorosis of pineapples growing on manganiferous soils by spraying the leaves with a solution of iron sulphate. As a result of this one discovery the value of the output of pineapples is estimated to have been increased to date by $10,000,000.

In the horticultural division leading varieties of tropical fruits, including bananas, avocados, papayas, mangoes, and breadfruits are being improved by breeding work, and successful propagation methods are being worked out in connection with such fruits as fail to come true to seed. Results worthy of mention are being secured with varietal selections of figs, mulberries, strawberries, and the poha or husk tomato. During the year approximately 25,000 plants and packages of seed of improved varieties were distributed to cooperators throughout the islands.

Agronomic work was directed principally toward the development of coarse forage grasses which will readily withstand continuous cutting. Such grasses are needed in Hawaii, where there is no cessation in the growing period. In an effort to help the farmer solve his immediate problems, the agronomist conducted thoroughly planned cooperative experiments on individual farms, where, among other things, crops forming the basis of the dairy and poultry industries were tested. In March, 1923, the agronomist left the station for a four months' trip to the Orient, where he will make a study of general-farming and poultry-raising methods applicable to Hawaiian conditions.

Work in the chemical division was devoted to the solution of problems arising in connection with the development of the starch industry and the preservation of various fruits and fruit products. Tests are being continued to determine the effect of soil, locality, and climate on the mineral constituents of Hawaiian-grown vegetables, and the effect of brackish irrigation water on certain crops growing on sand, loam, and clay soils. Fertilizer experiments with bananas and fertility-rotation experiments with pineapples and upland sugar cane are also being carried on.

In addition to traveling over 11,000 miles to visit and assist homesteaders, poultrymen, plantation managers, and ranchers, the extension agent for the island of Hawaii gave much of his time and attention to directing the work of the cooperative experiment station at Glenwood, cooperative work on the Parker ranch, Kamuela, to the fruit-tree nursery near Hilo, and to garden and club work in the schools. The general-extension activities of the central station extended to all the outlying islands, and included many kinds of service.

The station continues to maintain two substations, one at Glenwood, Hawaii, and the other at Haleakala, Maui. The former is operated as a well-balanced stock farm with dairy cattle predominating. Data obtained in experiments carried on at this farm are passed along by the extension agent to farmers similarly situated throughout the islands. At the Haleakala substation and demonstration farm investigations were made to determine the cultural requirements and adaptability of a large number of crops to the somewhat unfavorable climatic conditions prevailing on the slopes of the Haleakala volcano.

In the division of home-demonstration activities very pleasant relationships were established with various Territorial institutions and manufacturing concerns, and large groups of women, representing many nationalities, were reached by the collaborator in charge.

Under the direction of a club leader, boys' and girls' club work is being conducted in cooperation with the University of Hawaii, the Star-Bulletin Garden Contest Association, the Young Women's Christian Association, the Salvation Army Boys' Home, and the public schools.

At the central station a number of the buildings were repainted and several of the roofs were retreated with graphite paint to protect the shingles. Two cesspools were dug to improve the sanitary condition of the station dwellings. A thief-proof fence was built around the various experimental plats, and a start made toward fencing the experimental plats at the Tantalus substation.

During the year the following publications were issued by the station: Annual Report for 1921; Bulletin 48, Swine Raising in Hawaii, by F. G. Krauss; Bulletin 49, The Acid Fruit Lime in Hawaii, by W. T. Pope; and Bulletin 50, The Sweet Potato in Hawaii, by H. L. Chung.

REPORT OF THE HORTICULTURAL DIVISION.

By W. T. Pope.

AVOCADOS.

Studies were made of the growth of trees, habits of productivity, and quality of fruit of about 90 varieties of avocados. Many of the promising sorts were described and photographed for future record, and propagating wood of the better varieties was obtained for experimental work. The winter avocado is especially promising, since apparently it can be made to bear and ripen its fruit during the months of the year when the ordinary summer avocado is not in season. The fruit has a high food value, containing approximately 18 per cent of fat.

The nonbearing habit of certain avocado trees is now one of the most vital problems confronting growers. This trouble is similar to that reported from Florida and California, where a rather extensive study showed that the nonbearing condition is due to a failure in pollination. It is concluded from a study of the flower in relation to methods of pollination, begun at the station during the last blossoming season, that cross-pollination is necessary, at least with certain varieties, to assure satisfactory crop production, and the interplanting of varieties is recommended. Pollination experiments will be continued with the next blossoming season.

In most instances Hawaiian soil conditions are such that it is impracticable to raise budded or grafted avocado trees in nursery rows prior to transplanting them elsewhere. Growing trees in flowerpots, tin cans, and wooden boxes is an unsatisfactory method, owing to the complications which arise before the trees attain sufficient size and strength to permit of their being transplanted to the open. Although budding has been considered the best method of propagating varieties of avocado, budded trees invariably fail to make satisfactory growth. At the station an improved method of grafting very young seedling avocados is followed, using as scions the tender terminal shoots of desirable varieties. It is thought that this method will greatly reduce the time required to get young grafted trees in condition for transplanting.

In connection with propagation work, a study of avocado rootstocks was made during the year. Although local propagators prefer Guatemalan seedling rootstocks to either the West Indian or the Mexican rootstock in propagating varieties of Guatemalan avocados, results obtained from rather extensive experiments made at this station would seem to indicate that the Guatemalan is not superior to the West Indian rootstock, particularly when the seeds used in growing the stocks have come from fruit of good quality. These investigations also confirm results of studies in other parts of the world with asexual methods of propagation. Due to the similarity of their natures, both the Guatemalan and the West Indian types may be united by budding and grafting. Further investigation may show a definite advantage of some one combination over another.

MANGOES.

Several new varieties of mango trees, having fine qualities of productivity and flavor of fruit and showing immunity to attacks of the Mediterranean fruit fly, were added to the station collection during the year. Continued wet weather favored the development of a fungus disease (due to *Glœosporium mangiferæ*) at the time many of the trees were in blossom, and as a result a number of the flowers dropped and young foliage and fruit in various stages of development became splotched with black. Sprayings with Bordeaux mixture and lime-sulphur were ineffective, owing to the frequency of showers. Only part of the crop was destroyed, however, and trees blossoming later are now bearing their full crop of fruit. Mango trees in nearly all parts of the Territory showed great resistance to wind in a severe three-day wind and rain storm occurring in January, 1923, the branches remaining unbroken.

Some of the seedling mango trees of Victoria No. 9 are attracting considerable attention by producing fruit identical with that of the parent tree (Mango No. 9). The seeds of the latter are polyembryonic, which it is thought gives one seedling as the result of cross-pollination and several vegetative (parthenogenic) forms producing fruit very closely resembling that of the original parent tree.

Attempts to graft young seedling trees with scions of desirable varieties by a modified form of the side tongue-graft method were 96 per cent successful. This method is an improvement of 46 per cent over the other methods hitherto used most successfully.

BREADFRUIT.

In an experiment undertaken to develop plants from root cuttings of the seedless breadfruit tree, 400 young trees were produced from 600 five-inch cuttings taken from the surface roots. This very nutritious and wholesome fruit has practically ceased to be used in the Territory, mainly because of the difficulty with which the tree is propagated.

BANANAS.

Thirty-five different varieties of bananas are being grown at the station, and studies are being made to determine the best varieties of the so-called cooking bananas. Kona Maimaoli appears to be the best. This variety has a fine flavor, produces bunches weighing from 90 to 100 pounds, and is undoubtedly the finest of the varieties for shipping. The plants do not withstand much wind, but they do exceptionally well in the Kona district, where conditions seem to be the most favorable to growth. Varieties suitable for use as fresh fruit include the Chinese, Brazilian, and Bluefields, only the first of which is as yet grown extensively enough for shipping.

PAPAYAS.

The results of the papaya investigations continue to be encouraging. The plant responds quickly to favorable conditions. Several varieties, imported from other parts of the world, have as yet shown little difference from the varieties already grown. Two of the leading sorts, Station Accession No. 4618, a long variety, and Station Accession No. 4617, a round variety, continue to produce fruit of high flavor and flesh which remains firm during the cool wet months of January and February when other kinds are inferior in quality.

CITRUS FRUITS.

Experiments are being carried on with oranges, limes, lemons, pomelos, shaddocks, and citron, and budded trees of the Hawaiian (Polynesian) orange are being propagated from the best selected trees of the Kona district where citrus trees do well. The cooperative experimental work, covering two 1-acre plats and directed toward the standardization of this excellent variety, is making very fine progress. About 400 budded trees have been distributed to cooperative growers throughout the Territory. The orchard at the central station contains miscellaneous varieties of many kinds of citrus, all of which are doing well. Cowpeas, intercropped with citrus, made the most efficient green-manure crop of the several kinds under trial during the winter months.

GRAPES.

Trial plantings of the famous currant grapes of Greece are being made on the semiarid steep hill and mountain sides to determine the possibility of establishing a currant industry in Hawaii. The station has a number of varieties under test, including the Isabella, Concord, Tokay, Cornichon, Thompson's Seedless, Almeria, Zante, Malaga, fox, muscadine, Niagara, Scuppernong, Golden Queen, and a tropical grape (*Vitis tiliæfolia*). Isabella, a very prolific variety and well adapted to island conditions, may be made to ripen its fruit every month of the year. New varieties possessing desirable qualities are being grafted on Isabella rootstocks, and experiments are being made to determine the effect of pruning at different seasons on time of fruiting. Several thousand rooted plants were distributed during the year.

TOMATOES.

Tomato investigations are of importance in that they have for their object the production of varieties that will resist attacks of the Mediterranean fruit fly. So far, very few of the progeny from cross-pollinations have closely approached the ideal type. In progress is another experiment in which are being grown many desirable types having habits as well as characters to be combined, it is hoped, in the new and more substantial type.

NUTS.

The nut investigations of the year were confined to five species, the Macadamia, pistachio, walnut, almond, and cashew, and as yet have resulted in little more than making these nuts known to growers. Nut culture has excellent possibilities in Hawaii.

INTRODUCTION AND DISTRIBUTION OF NEW AND IMPROVED PLANTS.

Approximately 150 new varieties of plants were received by the station from the Bureau of Plant Industry, United States Department of Agriculture, and from interested persons living in various parts of the world. Many of these plants are of economic value in their native land and already give indications of being of value in Hawaii.

In addition to distributing a large number of thoroughly tested plants to interested growers throughout the Territory, the horticultural division also supplied limited quantities of new plant material, which had not been fully tried out by the station, to especially selected cooperative growers who are willing to assist in determining the value of new plants in various parts of the Territory.

REPORT OF THE AGRONOMY DIVISION.

By H. L. Chung.

Severe rain and wind storms occurring in the middle of January so severely damaged newly planted experimental plats as to necessitate replanting many of them. Root crops escaped more or less, and a large part of the corn matured sufficiently for harvesting.

GRASSES.

Napier grass (*Pennisetum purpureum*) is demonstrating its value as a forage crop for dairy cattle by rapidly putting out vigorous growth after a crop is cut for green feed. Many thousands of cuttings have been furnished to local dairymen for propagating purposes.

Guatemala grass (*Tripsacum laxum*) this year bloomed for the first time since it was planted, in August, 1919.

UBA CANE.

During the year Uba, or Japanese, cane tasseled. It has been extremely difficult to get this cane to flower, and when tasseling did occur, the station, working in cooperation with the Hawaiian Sugar Planters' Association, hybridized the variety with pollen from the best sugar cane varieties available for the production of a superior progeny. The hybrids are under observation and will be thoroughly tested to determine their sugar-producing possibilities and their adaptability to local conditions, especially with regard to ability to resist disease.

SWEET POTATOES.

During the year a test was made to determine the comparative yields, quality, and ability to resist fungus and insect attack, of 34 native varieties of sweet potatoes from Kauai and Maui and 37 varieties from the mainland. All but 5 of the imported sorts were grown for the first time at this station. Comparison of the native varieties with those grown at the station has shown the latter to be true to name as originally given by the native Hawaiians. The following table gives the comparative yields of native and imported varieties:

Comparative yields of locally grown and imported varieties of sweet potatoes.

Station No.	Locally grown varieties.	Calculated yield per acre.	Station No.	Imported varieties.	Calculated yield per acre.
		Tons.			*Tons.*
1596	Mohihi	2.04	1563	Yellow Jersey	2.22
1597	Manana	8.17	1564	Big Stem Jersey	3.74
1598	Mahina	4.88	1568	Big Leaf Improved	3.97
1599	Pu	4.22	1550	Big Leaf	3.06
1600	Manuia	2.89	1553	Early Carolina	3.28
1601	Kiikiki	2.38	1549	Waite's Improved Big Stem	1.02
1602	Mohihi	2.83	1571	Early Carolina	2.22
1603	Mauaniana	2.38	1578	do	2.22
1604	Naleimaile	2.22	1556	Porto Rican	3.51
1605	Pikolehua	2.49	1562	Triumph	6.01
1606	Kauai	1.70	1548	Dixie Yam	5.33
1607	Koloa 1	1.87	1551	Old Long Red	1.70
1608	Koloa 2	7.26	1547	Jewel Yam	1.59
1609	Koloa 3	4.25	1554	Belmont	2.15
3844	New Era	5.96	1555	New Gem	3.17
1611	Kapaa	3.85	1570	Creola	2.04
3842	Madeira	2.25	1575	Vineless	1.93
3838	Delicious Yellow	0.73	1574	General Grant Vineless	5.56
3874	Tantalus	2.69	1566	Japanese Brown	3.40
98A	Seedling	3.17	1582	Myers' Early	3.88
3871	Yellow Yam	2.94	1572	Pumpkin Yam	3.88
88A	Seedling	2.89	1573	Pierson	5.96
114C	do	4.93	1519	Yellow Yam	3.74
3856	do	2.95	1559	Southern Queen	1.93
111A	do	2.65	1569	Miles' Yam	1.93
3856	Puukeokeo	2.89	1576	Norton Yam	2.61
3845		3.74	1581	Shorthorn	4.42
39		3.40	1584	Enormous	6.24
1324		3.57	1577	Pumpkin Yam	2.95
3851	Kikola	2.89	1583	Yellow Strasburg	5.10
1345	Berlina	4.09	1561	Nancy Hall	1.81
56		2.38	1560	do	2.49
439		2.20	1580	Red Bermuda	6.35
3840	Laupahoehoe	2.38	1565	Japanese Brown	1.36
			1567	Red Jersey	3.74
			1591	Porto Rican	5.07
			1592	Triumph	4.53

MANGEL WURZELS.

The varieties Giant Yellow Intermediate, Long Red, Yellow Globe, and Golden Tankard, obtained from England for trial as a winter crop, were planted September 8, 1922, and harvested March 8, 1923, yielding approximately 2.58, 1.35, 1.46, and 3.31 tons, respectively, per acre. Giant Yellow Intermediate and Golden Tankard made the heaviest yields and continued to grow when the other two varieties appeared to be in a dormant condition.

SUNN HEMP.

Sunn hemp (*Crotalaria juncea*) continues to give great promise as a green manuring crop, especially in connection with wornout pineapple lands. In culture tests made during the year, seed was produced at the rate of 1,038 pounds per acre. Requests for seed came from the mainland as well as from local homesteaders and pineapple growers. Selection work for improvement in foliage and seed is under way, it being the desire of the station to develop leguminous green-manure crops which will not only make efficient cover crops and produce seed, but will also quickly produce an abundance of green manure for plowing under for soil-improvement purposes. Sunn hemp and pigeon peas are the most promising of the various green-manure crops now under test.

DISTRIBUTION OF SEEDS AND CUTTINGS.

The production of seeds and cuttings early in the last fiscal year enabled the station to meet the unusually heavy demands of the present year. A large part of the distributions were made to schools for school-garden work. In addition to 510 corms or tubers of edible canna, distribution from July 1, 1922, to June 30, 1923, was made in amounts as follows:

Seeds and cuttings distributed during the fiscal year ending June 30, 1923.

Crop.	Cuttings.	Seed.	Crop.	Cuttings.	Seed.
	Number.	*Pounds.*		*Number.*	*Pounds.*
Guam corn		211	Napier grass	47,434	
African sorghum		8	Merker grass	10,408	
Yam beans		3	Pigeon peas		54
Hybrid cowpeas		130	Alfalfa		25
Velvet beans		7	Crotalaria		70
Clover		3	Beans (all varieties)		158
Peanuts		33	Bermuda grass	2,746	
Uba cane	3,446		Sweet potatoes	7,601	

POULTRY.

The poultry work was carried on along essentially the same lines as last year. Considerable time was devoted to demonstration work in flock improvement and the treatment of disease. The poultry department of the University of Hawaii was assisted in conducting its first egg-laying contest, and each contesting hen was examined for characteristics indicating egg-laying capacity. Local poultrymen were materially aided in obtaining desirable breeding and laying stock, over 5,000 such fowls being imported between November, 1922, and February, 1923. Poultry raising is being carried on on a rather extensive scale on Maui. The district of Makawao is ideal for poultry raising. Homesteaders on this island were assisted in drawing plans for poultry houses and in overcoming problems connected with poultry management.

REPORT OF THE CHEMICAL DIVISION.

By J. C. Ripperton.

BANANAS.

Fertilizer experiments with the Chinese banana have almost without exception given negative results in past years. That some form of fertilizer is needed, however, is proved by the stunted appearance of the plants and the growing of the fruit in small bunches in many fields. Climatic factors are not the cause, since certain fields in a given locality produce excellent bananas, while others closely adjacent and given similar treatment yield very inferior fruit. As a result of rather elaborately planned fertilizer experiments carefully carried out during recent years by the station and individual growers, as well as of observations of the nature and feeding habits of the plant, it is concluded that in certain sections the banana is prevented by adverse soil conditions from utilizing the plant food applied. Results of analyses of the seepage water at the lower boundary of a fertilized field to determine the effect of heavy applications of irrigation water on leaching of the readily soluble fertilizer from the feeding zone of the plants, showed a very appreciable leaching of all the fertilizer elements. Accordingly, an experiment was begun to determine the best method of applying fertilizer to the crop. The same quantity of a complete, ready-mixed commercial fertilizer was applied to each plat, and four different methods of application were used. In the first test the total quantity was applied at one time about the base of the plant; in the second test the total quantity was placed in the sides of the furrow and about the level reached by the water during irrigation; in the third test the total quantity was given in six monthly applications about the base of the plant immediately before irrigation; and in the fourth test the total quantity was given in six monthly applications about the base of the plant immediately after irrigation. The first crop of the experiment has been harvested and fertilization of the second crop completed. It is expected to carry this experiment through two more crops.

Pot and field experiments are to be conducted to permit a study of the general feeding habits of the banana, its susceptibility to various soil toxins, and the physical properties of the soil affecting growth.

FERTILITY-ROTATION EXPERIMENTS WITH PINEAPPLES, UPLAND SUGAR CANE, AND PIGEON PEAS.

This experiment was undertaken to determine the feasibility of providing rotations for pineapples and sugar cane and at the same time preventing the usual soil depletion accompanying the single-crop system by growing pigeon peas as a green-manuring crop. The decrease in yields with continuous cropping to pineapples is very manifest in Hawaii. A fertilizer experiment is being carried on in conjunction with the rotation experiment. The experiment has been carried through two crops each of pineapples and sugar cane, and the pigeon pea crops have been alternately plowed under and removed. The pineapple and sugar-cane areas are being plowed at the end of the second crop harvest, and the second step in the rotation will be begun this fall (1923) when the pineapple plat will be planted to sugar cane, the sugar-cane area to pigeon peas, and the pigeon pea area to pineapples.

HAWAIIAN STARCHES.

Investigations were continued with various tropical starches to determine the more scientific phases attending their commercial development.

Tree fern.—Experiments with the tree fern for the production of starch were concluded. It has been found that, relative to replanting cut-over areas, an average of three young tree ferns can be obtained from each felled mature tree fern. The rate of growth of this genus is, however, too slow to make it commercially practicable to replant the tree fern for its starch content.

Edible canna.—Preliminary investigations on certain phases of the culture of edible canna and the properties of its starch were completed, and the following conclusions drawn: The chemical composition of a hill of edible canna is fairly constant, regardless of its age. Although there is considerable difference between the mature and the immature type of tubers, the hill as a whole remains practically constant. The feeding value of the edible canna, both tubers and tops, is about the same as that of the other common tuberous and nonleguminous forage crops. Canna starch is characterized by its unusually large granules, and its properties are similar to potato starch. It is thought to have possibilities as an industrial starch.

Edible canna investigations are being continued. A fertilizer experiment has been begun to learn the best method of applying fertilizer to the crop, and another has been planned to ascertain the fertilizer formulas best adapted to it. Cooperative investigations have been undertaken with a local starch company to solve the problems incident to the manufacture of the starch and the utilization of the by-products.

JELLY MAKING FROM TROPICAL FRUITS.

In an attempt to introduce into commercial jelly making in Hawaii more scientific methods than are now used, the chemical division conducted experiments with fruit juices for pectin and acid, determined the proper sugar ratios, and made a study of the resulting products.[1] Much of this work has been carried on in cooperation with a local jelly company.

Preliminary work has been started to determine the feasibility of using commercial pectin in making certain tropical jelly and jam products. Various formulas for its use are being developed, and studies made of the relative cost and palatability of the resultant products. Work of a more fundamental nature is being undertaken to determine the physical differences in the pectins of different fruits, the relative "gelling strength" of each pectin, and the character of the gel produced.

EFFECT OF CLIMATE AND SOIL ON THE COMPOSITION OF HAWAIIAN VEGETABLES.

The opinion prevalent among certain classes in Hawaii that locally grown vegetables are lacking in certain essential mineral constituents is not without scientific foundation. Shorey[2] found the forage crops of the island deficient in lime, and Johnson[3] showed that pineapples are unable to assimilate iron from certain soils. As a result of this opinion, locally grown vegetables are discriminated against in favor of canned products from the mainland. Preliminary analyses of a series of spinach samples grown on the mainland and in Hawaii, indicated that generally this vegetable is richer in mineral constituents than is the mainland spinach. In a rather extended experiment, planned to determine the effect of tropical climate and volcanic soil on the composition of vegetables, two leaf vegetables (spinach and cabbage), two root vegetables (carrots and beets), and two pod vegetables (peas and beans), were selected for study. Seed was obtained from a reputable firm and planted in two widely separated areas on the mainland (Virginia and Washington), and likewise in two localities on Oahu. The vegetables from each place were dehydrated and together with a sample of the soil in which they were grown were sent to this station for analyses. Both vegetables and soils are now being analyzed.

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[1] Hawaii Sta. Bul. 47, Applications of the principles of jelly making to Hawaiian fruits, by J. C. Ripperton.

[2] Hawaii Sta. Bul. 13, The composition of some Hawaiian feeding stuffs, by E. C. Shorey.

[3] Hawaii Sta. Press Bul. 51, The spraying of yellow pineapple plants on manganese soils with iron sulphate solutions, by M. O. Johnson.

SALT TOLERANCE OF VARIOUS PLANTS GROWN IN SAND, LOAM, AND CLAY SOILS.

Extensive investigations were made to determine the tolerance of various crops to brackish irrigation water and with soils derived from igneous and metamorphic rock and under Temperate Zone conditions. Data on the tolerance to sodium chlorid of various crops grown on volcanic soils and under tropical conditions are rather fragmentary; and likewise, both the nature and extent of the physical and chemical effects of this salt on volcanic soils are unknown. The investigations included lysimeter, laboratory, and field experiments.

Lysimeter experiments.—Typical soils of Hawaii were placed in lysimeters and planted to alfalfa (Pl. I, fig. 1), Napier grass, rice, sugar cane, and carrots. The effect of varying concentrations of sodium chlorid in the irrigation water upon the growth of the several crops was studied and the leachings from the lysimeters were collected and analyzed. (Pl. I, fig. 2.) These studies will be carried through two or three crops to determine the cumulative effect of the salt upon the soil.

Laboratory experiments.—Studies were made of the physical and chemical changes taking place in the soils used in the lysimeter experiments, and also of soils taken from various districts which have been irrigated with brackish irrigation water for many years. Field observations and laboratory tests thus far conducted indicate that these changes are very appreciable and eventually will become a serious menace to the productivity of the soil.

Field experiments.—The salt content of both water and soil was determined in the important districts using brackish irrigation water, and the character of the crops and condition of the soil were noted. During the year two crops were grown in the lysimeters. Methods were devised for ascertaining the physical changes taking place in these soils. The irrigation water used on the islands of Kauai, Hawaii, and Oahu was tested and soil samples collected for further study.

REPORT OF EXTENSION AND DEMONSTRATION WORK ON THE ISLAND OF HAWAII.

By R. A. Goff.

GLENWOOD SUBSTATION AND DEMONSTRATION FARM.

F. X. Helbush, the collaborator in charge of the Glenwood substation and demonstration farm, is making every effort to maintain this farm as a self-supporting unit. During the year the dairy herd increased to 31 head, 7 of which are young females. A registered

Holstein bull now heads the herd. Eight heifers will come in this year, bringing the milking herd up to 15. Three old Berkshire sows and two of the best of their litters are being kept. The purebred White Leghorn poultry flock increased from 300 to 475 laying hens. It is planned to increase this flock to 800 laying hens this year and to 1,000 the year following, and during these two years to bring up the dairy herd to 20 milking cows. Napier grass and pigeon peas are being grown to help feed the animals. The eggs, cockerels, butter, calves, and hogs will be marketed locally. Muscovy and Pekin ducks were purchased as foundation stock for the production of progeny for experimental purposes.

Farm buildings for the animals were altered and enlarged during the year. A 40-foot extension was added to the cow stable, an iron-roof shed was erected for the hogs, an iron-roof awning was placed in front of the barn, and a new fence was built around the 30-acre pasture lot. New roofs were put on the poultry houses, and the yards were rearranged to permit of larger runs. A dwelling for a laborer who also acts as night watchman was erected near the poultry houses, and a water tank having a 10,000-gallon capacity was built. Two others of the same size were purchased and will be put up this year.

WORK AT THE KAMUELA COOPERATIVE EXPERIMENT STATION.

The Kamuela Experiment Station is operated by the Parker ranch. The area in pasture grasses and field and forage crops was enlarged during the year, and such crops as Russian brome, redtop, Harding grass, Peruvian winter grass, *Paspalum larranagai*, *P. notatum*, *Phalaris bulbosa*, Australian tall fescue, purple vetch, alfalfa, and sweet clover, which looked promising at the end of the first year, were planted in one-third acre plats. Selected seed of corn grown last year is being planted in six areas totaling 2 acres. Seed of 16 kinds of range grass, obtained through the Montana Experiment Station from varying altitudes and from wet and dry localities in Montana, will be planted in small plats to test their adaptability to conditions prevailing in the ranching districts of Hawaii. Seeds, cuttings, and roots of crops growing well at the station were distributed to homesteaders in the Kamuela district and to dairymen and ranchmen in Kona, Kau, and near Hilo.

GENERAL ACTIVITIES OF THE EXTENSION AGENT.

Talks to school children and homesteaders.—Talks on gardening and garden crops were given to school children at morning assembly; spraying and proper methods of cultivation demonstrations were conducted; and discussions were given on seed varieties and depth of planting. Illustrated lectures on butter making, pruning, and budding, as well as discussions of crops best suited to the different localities, poultry, dairying, and hog raising, were given assembled groups of homesteaders in the various districts.

Boys' club work.—Each interested child of the island schools having a sixth or higher grade, was given a quantity of corn and seed potatoes sufficient to plant a minimum of 1,000 square feet. Bulletins on corn and potato growing were distributed to the young gardeners, and arrangements were made with a local poultryman to

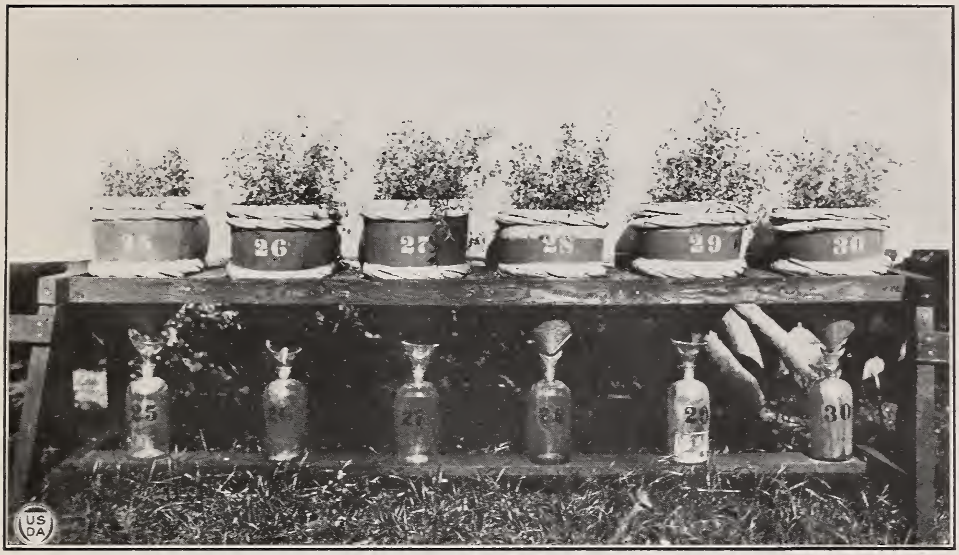

FIG. I.—METHOD OF DETERMINING SALT TOLERANCE OF ALFALFA.

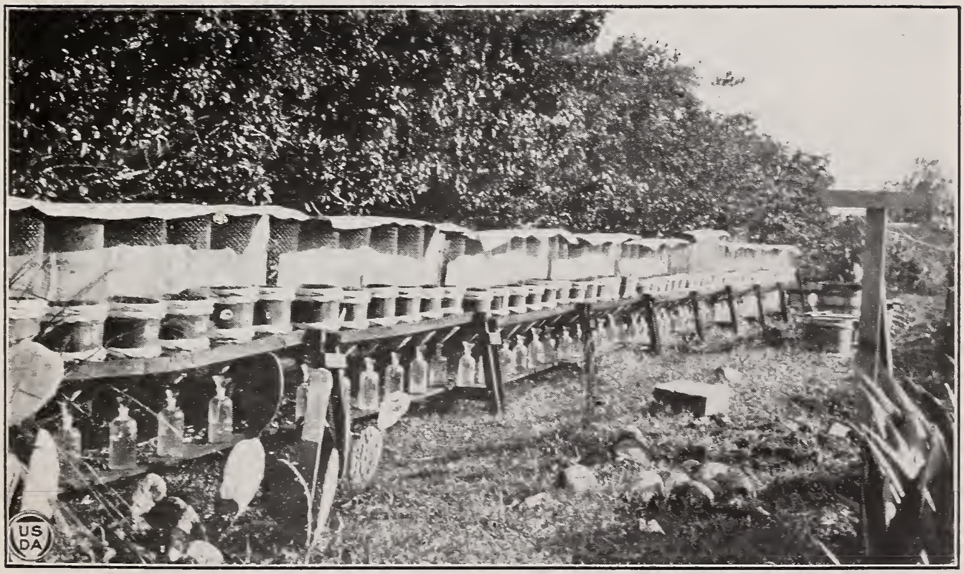

FIG. 2.—GENERAL VIEW OF LYSIMETERS IN SALT TOLERANCE EXPERIMENTS.

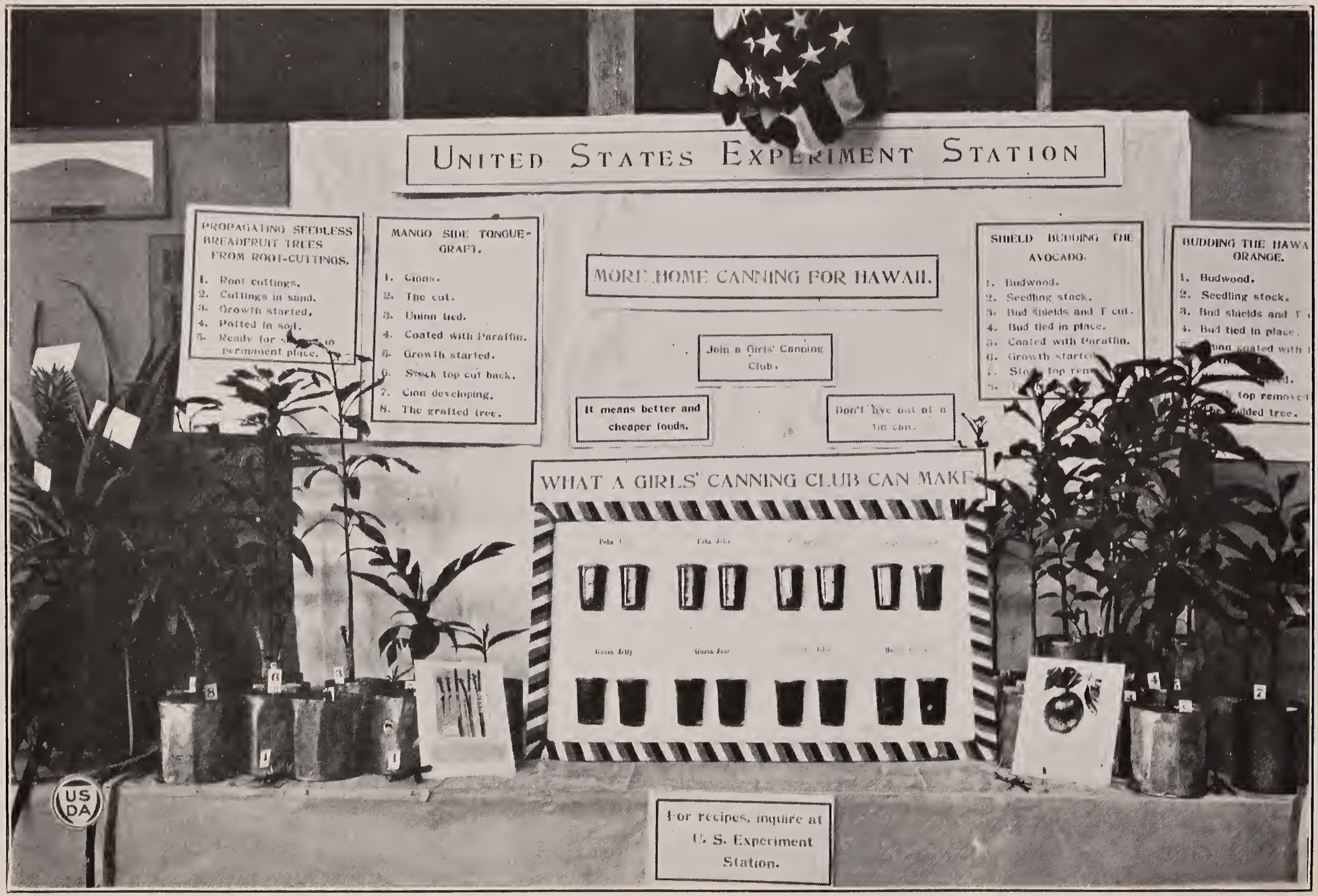

EXHIBIT OF HAWAII STATION EXTENSION DIVISION AT AGRICULTURAL FAIR.

supply a setting of eggs to each boy interested in poultry work. Chickens were hatched and raised to 3 months of age, at which time they were exhibited at the county school fair and the poultryman was given his choice of one pullet to pay for each setting of eggs. Farmers' Bulletins on feeding and raising chicks were distributed to the boys and visits made to their homes, where assistance in making chicken coops and runs was given. Various problems were discussed at monthly meetings.

School and home-garden work.—Thirty schools entered the school-garden contest during the year with gardens ranging from one-fourth of an acre to 3 acres. Seed of corn, potatoes, alfalfa, pigeon peas, and sweet clover, together with instructions regarding each crop, were given to the children of 12 of the schools. Several times during the year the schools were visited and the extension agent acted as one of the judges in the different districts at the close of the contest. The island was divided into two main districts in the home-garden contest, which made it possible to have the children of each garden compete with those of the same grade in each of the two districts.

Hawaii school fair.—The best products from the gardens of the whole country were displayed in the agricultural section of the Hawaii school fair. Fully 4,000 children visited the fair. Pupils and teachers obtained the names of varieties of seed doing well in schools other than their own for the purpose of planting the most successful kinds in the future. The extension agent acted as chairman of the agricultural committee, and entry lists were made out, interest in entries was aroused in the different schools, judges were secured, exhibits displayed, and awards sent to the winners.

Seed distribution.—Owing to difficulty in obtaining sufficient feed for cows, pigs, and poultry, especially in the sugar-cane districts, where large areas are devoted to cane growing, the extension agent persuaded homesteaders in each district to prepare a plat for various field crops and distributed seed of corn, alfalfa, and sweet clover, and cuttings of Merker grass, Napier grass, and Uba cane. Sweet potato cuttings and vegetable seeds of varieties suited to the different localities were also distributed. The seed of the Solo papaya, which is a good table variety, and of a larger growing papaya for use as a hog feed, was given to those requesting it.

Distribution of literature.—United States Department of Agriculture Farmers' Bulletins and bulletins published by the station on vegetable gardens, field and forage crops, livestock, and farm buildings were distributed during the year. Extra copies of seed-house catalogues were obtained for those requesting them, and newspaper articles dealing with agricultural topics of especial interest were loaned to various farmers.

Assistance in marketing.—Samples of products grown in the Kamuela and Kona districts were taken to dealers in Hilo, and arrangements made for future shipments. Demonstrations were given producers in proper methods of sorting and grading, and suitable containers were obtained for them. Dealers who have been purchasing a large supply of potatoes, poultry, and dairy supplies from the mainland cooperated in marketing the local produce. The extension agent also assisted in marketing sweet corn, rhubarb, and avocados.

Assistance in boy scout activities.—The extension agent continued to act as scout commissioner for the island and as examiner for boy scouts competing for the agricultural merit badge.

Fruit tree nursery.—Buds from grapefruit and navel and Kona orange trees were grafted on 300 wild-lemon seedlings, and more than 500 avocado seedlings were worked over into winter-bearing trees. Many of them were distributed to different parts of the country and withstood transplanting without injury. About 800 citrus seedlings are now ready for budding and as many avocado seeds are being planted for the coming year.

Spraying demonstrations.—In the Kohala and Hamakua districts, where growers experience difficulty in keeping pineapple plants in a healthy growing condition, due to lack of available necessary plant food in the soil, demonstrations of the proper methods of treating the soil were conducted. Demonstrations were also given of the preparation and application of Bordeaux mixture as a control measure for potato blight occurring in the Hamakua, Kamuela, and Kona districts; as well as of poison bait for cutworms, and Paris green and arsenical mixtures for garden pests occurring in the volcano district near Hilo.

Assistance in planting windbreaks.—Seed and seedlings of eucalyptus, black wattle, Monterey cypress, and ironwood trees were distributed in the Kau, Kohala, and Kamuela districts.

Miscellaneous activities.—Active assistance was given farmers in bringing in from the mainland at least 5,000 laying hens. Assistance was also given in culling the fowls in an egg-laying contest conducted by the University of Hawaii. Demonstrations of the proper methods of utilizing locally grown fruits and vegetables were carried on in cooperation with various Territorial agencies which are interested in nutritional work with underweight children. In an effort to cultivate a liking by the people for milk and butter as well as for home grown fruits and vegetables demonstrations were also given setting forth the value of fresh, locally produced food products. At some of these meetings the members of the extension division came in contact with parents as many as 520 times during a single month.

HALEAKALA SUBSTATION AND DEMONSTRATION FARM.

By H. F. WILLEY, *Superintendent.*[4]

At the Haleakala substation and demonstration farm, where normally the rainfalls are light and the winds high, unusually heavy torrential storms occurred during the year. Several rows of *Eucalyptus robusta* were successfully established as windbreaks along the windward side of the farm, and Napier grass and Uba cane were set as secondary windbreaks at intervals across the farm rows. A road was constructed across the gulch dividing the farm unit into two sections, and the roadway leading from the main road to the residence and farm buildings was improved. The field as a whole was given deeper tillage than formerly, and, as a result, the crops are responding satisfactorily. Approximately 194 varieties of 74 crops were planted, including pineapples, pigeon peas, field corn, sweet corn, pop corn, tomatoes, and sweet potatoes. Fully 600 visitors to the farm inspected the various plantings.

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[4] Temporarily employed.

In addition to assisting with school-garden activities and the Maui County Agricultural Fair held in October, 1922, the superintendent gave suggestions to homesteaders relative to improved methods of planting and tillage, selected and ordered seed for homesteaders, and obtained prices on fence material and purebred stock for them.

REPORT OF HOME DEMONSTRATION ACTIVITIES.

By Mrs. Nellie A. Russell.

The home-economics demonstrator again instructed groups of Japanese, Chinese, Philippine, Portuguese, and Hawaiian women in the art of home making in harmony with American ideals. These women are anxious to learn methods that are an improvement over those to which they have been accustomed, especially in regard to the utilization of local fruits and vegetables. A large number of the demonstrations were given with the assistance of interpreters to groups of working mothers during the noon hour. Rooms were provided for the occasion by the various business concerns which have become interested in this phase of Americanization work among the several nationalities. Special instruction and demonstrations in cooking and serving meals, as well as lessons in dressmaking and millinery, were given to older girls. The sewing classes require a great deal of individual attention, since the teaching of sewing does not lend itself readily to group presentation.

BOYS' AND GIRLS' CLUB WORK.

By Mabel Greene.

As soon as the club leader arrived in Hawaii in April, 1923, efforts were made to have the boys' and girls' club work correlated with the work of the public schools under the direction of teachers who are trained in agriculture and home economics. The public schools, beginning with the fifth grade, have a very definite place in their curricula for these studies. Club members are also receiving instruction in how to keep records, conduct business meetings, and assist in public demonstration work. The latter activity has a far-reaching influence upon the older people in each neighborhood. During the year club work was organized in three districts in Honolulu. Canning, dairy, garden, rabbit, poultry, home-management, and sewing clubs were organized, with an enrollment of 110 members. Considerable time was spent in studying local conditions and in establishing pleasant cooperative relationships for conducting the work. The garden club work embraces 46 members at the Salvation Army Boys' Home, where a new tract of land has been made available. Agricultural slides, furnished by the United States Department of Agriculture, were shown at the various meetings by means of a stereopticon; and corn, beans, and peanut seed, together with young papaya trees and sweet potato cuttings, were distributed to members. Demonstrations of the best methods of planting were given at the time the distribution was made.

A group of girls, ranging in age from 16 to 18 years, are studying home-management problems in coopertaion with the club department of the Young Women's Christian Association. They have already learned how to use the fireless cooker and are planning to make one for their club rooms, which they are furnishing. These girls have completed a luncheon set and expect to learn canning work during the July and August meetings.

The school fair in Honolulu, May 25 and 26, 1923, afforded an excellent opportunity for parents and others interested to view the agricultural and home-economics work being done in Maui, Hawaii, and Oahu by the boys and girls. The extension agent served as a judge of the cooking contest held May 26. Club work will be closely affiliated with contest work, but separate club records will be kept and public demonstrational work will receive increased emphasis. The exhibit of local food products of the central station was allotted space in the Territorial Normal School exhibit (Pl. II). The club leader will meet the teachers attending the summer session, June 25 to August 3, 1923, to tell them of the purpose of the boys' and girls' club work and explain to them how they can assist in furthering it.